

# Conceptual Design of a Europa Lander Mission

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## Abstract

A Europa Lander mission has been assigned high priority NASA's Space Science Enterprise Strategic Plan. JPL worked with the cognizant NASA science team to develop a concept capable of satisfying the principal goals of such a mission.

Europa is one of the most scientifically interesting objects in the solar system because of the strong possibility that a liquid water ocean warmed by tidal heating exists underneath its ice-covered surface. If a subsurface ocean exists on Europa, it can be assumed to contain both organic molecules and heat sources from tidal effects, the decay of radioactive elements, and geophysical mechanisms. Europa's subsurface ocean environment may be similar to that of the deep ocean hydrothermal vents on Earth where life has recently been detected. If life exists (or existed) on Europa, it may pervade the liquid portions of the planet and perhaps be detectable in the dark fracture-filling material from recent ocean outflows on the planetary surface. The primary scientific goals of the proposed Europa Lander mission will be to characterize the surface material from a recent outflow and look for evidence of pre-biotic and possibly biotic chemistry. Secondary scientific goals will be to study the seismicity of the European interior and to conduct other geophysical experiments to gain information on Europa's internal structure.

The mission concept described in the paper involves landing a single spacecraft on the surface of Europa with the capability to acquire samples of material from 1 meter below the surface, perform detailed chemical analysis of the samples, and transmit the results directly to Earth. A Delta class launch vehicle is used for the direct transfer to Jupiter, arriving after a flight time of roughly 2.5 yr. A Ganymede flyby as the spacecraft approaches Jupiter reduces the energy needed for the Jupiter orbit insertion (JOI) and perijove raise (PJR) maneuvers, which result in about a 200-day orbit. There follows a sequence of outer Galilean satellite flybys augmented by propulsive maneuvers to reduce the energy of the orbit until it is inside Ganymede's orbit. Then, a series of reverse Europa flybys pump the orbit down to a 6:5 resonance with the target satellite. Europa orbit insertion (EOI) burn follows, with the spacecraft ending up in a 100-km orbit around the satellite, ready for the descent burn to the surface. Because of the large delta V required (4 km/sec), the propulsion system comprises about 90% of the 900 kg launch mass.

Technology advances needed to enable useful science return from a landed mission on Europa are identified in the paper. The spacecraft will require novel, lightweight, radiation-tolerant components, particularly for the propulsion system. It will also require new devices for acquiring, distributing, and processing surface material and it must be able to perform a precision landing on Europa's surface. However, perhaps the most critical new technologies are those necessary for the instruments which will perform the desired scientific investigations. In particular, many instruments for studying pre-biotic and biotic chemistry are either at the earliest stages of technological development or are not yet being developed for in-situ exploration. Among these are a miniature, portable UV-visible-near-IR spectrometer from 200 nm to 5000 nm, a capillary electrophoresis device to study the chirality of amino acids (dominance of either chirality would be an unambiguous bio-signature), and a device to study the number of carbon atoms in fatty acids (more even-chain than odd-chain fatty acids would be an indicator of life). In addition to minimizing the mass and power requirements of each instrument separately, techniques for minimizing

the mass of the entire landed instrument package should be developed. The paper provides a detailed discussion of the benefits and development status of the key spacecraft and instrument technologies needed to accomplish the Europa Lander science objectives